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THE IMMATURE STAGES AND BIOLOGY OF *MALLOTA POSTICATA* (FABRICIUS) (DIPTERA: SYRPHIDAE)

Chris T. Maier

Abstract.—The immature stages of *Mallota posticata* (Fabricius), which are described and illustrated, occurred in or near wet treeholes in deciduous trees. Larvae developed in the wet treehole detritus upon which they fed. In central Illinois, larvae of univoltine *M. posticata* attained full size by late summer, 2½–3½ months after hatching, and then they entered diapause. In the spring, they usually crawled out of treeholes and pupariated in the soil at the base of the tree. Laboratory-reared larvae required several months of chilling to terminate diapause and subsequently to pupariate. Males generally pupariated before females, but both remained in the puparium about 13–14 days when they were maintained at 22°C and on a 17 hour photophase and a 7 hour scotophase. Adults exposed to a 0400–2100 photophase eclosed mostly between 0600 and 1000—the equivalent of morning hours in nature.

In the field, adults fed upon open, actinomorphic blossoms which produced substantial quantities of pollen—a requisite for normal ovarian development. Mating, which is described, occurred near flowering plants and near treeholes. Females readily oviposited (17.7 ± 1.30 eggs per clutch) in artificial oviposition containers placed in the forest. Oviposition in containers occurred principally in June between 1100 and 1800 CDT.

The numerous investigations on syrphids in the tribe Eristalini deal mostly with representatives of the genus *Eristalis*, especially *E. tenax* (L.), and only rarely with members of other genera. Eristaline larvae, "rat-tailed maggots," are adapted for an aquatic existence. In particular, they have an extensible, caudal respiratory tube for obtaining atmospheric oxygen, anal papillae for facilitating ionic exchange and an elaborate filtering apparatus for feeding on detritus (Hartley, 1963; Hase, 1926; Krogh, 1943; Krüger, 1926; Roberts, 1970; Wahl, 1900; Wichard and Komnick, 1974). These structures and the external sensory organs have provided most of the characters used in taxonomic descriptions of larvae (Dixon, 1960; Hartley, 1961; Hennig, 1952). Dixon (1960), Doležil (1972), Hartley (1961), Hennig (1952), Johannsen (1935) and others published partial keys to third-instar eristaline larvae.

The larvae of *Mallota bautias* (Walker), *M. cimbiciformis* (Fallen) and *M. posticata* (Fabricius) develop in detritus-containing rot pockets, usually wet treeholes in upright deciduous trees (Becher, 1882; Britten, 1917; Coe, 1953; Johannsen, 1935; Lintner, 1882; Lundbeck, 1916; Snow, 1949). Johann-

sen (1935), Lintner (1882), Morse (1910) and Snow (1949) described the gross external morphology of one or more of the immature stages of *M. posticata* but largely ignored its life history. The taxonomic descriptions are not sufficiently detailed for use in comparative studies. Furthermore, I shall show that Johannsen's (1935) description of the anal papillae of the larva is erroneous. Unfortunately, Hennig (1952) and Snow (1949) incorporated the spurious information into their taxonomic keys.

Adults of *M. posticata*, apparent Batesian mimics of bumblebees, visit open, actinomorphic blossoms from April to July in the eastern United States (Graenicher, 1910; Robertson, 1928; Waldbauer and Sheldon, 1971; Waldbauer et al., 1977; Maier, unpublished data). Nothing else is published about the behavior of adults except for Curran's (1925) description of the oviposition behavior of an unidentified species of *Mallota*. Fashing (1973, 1974, 1975 and 1976), however, reported that *M. posticata* females are dispersal agents for two species of treehole-inhabiting mites.

Materials and Methods

Descriptions are based on specimens collected in nature and on others reared in the laboratory. Live eggs, larvae and puparia were used for most measurements of external structures. Measurements that were made on immatures or on biological events are usually reported as the mean ± standard error.

The principal research site, Sand Ridge State Forest, is in an extensive sand area in central Illinois near the Illinois River. The vegetation at Sand Ridge consists mostly of oak-hickory forest, disturbed sand prairie, and pine plantations (Maier, 1977a). The forest is dominated by the oaks *Quercus marilandica* Muenchh., and *Q. velutina* Lam. and by the hickories *Carya ovalis* (Wang.) Sarg. and *C. tomentosa* (Poir.) Nutt.

Laboratory colonies were started with the eggs of wild females and maintained for three generations without noticeable deleterious effects. The standard diet for rearing larvae was a 1:1 mixture of Purina Fly Larvae Media (Ralston Purina Co., St. Louis, Missouri) and homogenized treehole detritus. The mixture was saturated with water and usually supplemented with 3–4 grams of Vitamin Diet Fortification Mixture (ICN Pharmaceuticals, Inc., Cleveland, Ohio) per liter of wet diet. Larvae reared in crispers at 22°C and on a 17 hour photophase and a 7 hour scotophase reached full size in approximately three months and then entered diapause. One month later, they were placed in crispers containing moist, coarse treehole detritus and kept at 2°C and on a 10 hour photophase and a 14 hour scotophase. After 4–5 months, the larvae were transferred to 6.5 × 12.5 cm crystallizing dishes which were placed in crispers partially filled with sand. The dishes were filled with the semi-artificial diet and exposed to the initial

temperature and photoperiod regimes. In 1–3 weeks, the larvae crawled out of the rearing dishes and pupariated in the sand.

Adults were usually kept in plastic-covered 0.6 × 0.6 × 0.6 meter cages and maintained at 75% relative humidity, at 22°C, and on a 17 hour photophase and a 7 hour scotophase. Each cage contained two Petri dishes of pollen (collected in a pollen trap on a honeybee hive), two dishes with a solution of 10% glucose and 10% sucrose, and a 4 liter plastic jug for oviposition. The jug had a 10 cm circular opening on the side and held 1.5 liters of homogenized, water-soaked treehole detritus and strips of bark. The experiment monitoring ovarian development was carried out in 0.3 × 0.3 × 0.3 meter cages.

The oviposition containers described above were also used to record egg-laying activity in nature. Seasonal and diurnal patterns of oviposition were measured with 20 and 30 containers, respectively.

Descriptions of the Immature Stages

Egg.—Length 1.5 ± 0.01 mm, maximum width 0.6 ± 0.02 mm ($N = 10$). Elongate oval in outline, ends bluntly rounded (Fig. 1). White; chorionic surface microscopically sculptured, pattern under light microscope as in Fig. 1.

Mature third-instar larva.—Body length 20.8 ± 0.72 mm, maximum width 6.4 ± 0.12 mm, length of retracted caudal respiratory tube 13.6 ± 0.58 mm ($N = 14$); ratio of body length to retracted respiratory tube length 1.5:1.0.

Body slightly fusiform, truncate anteriorly, abruptly tapered posteriorly to base of caudal respiratory tube (Fig. 2). Cuticle translucent in life, cream to dirty white after fixation. Segmentation indistinct; longitudinal plicae anteriorly, numerous transverse plicae posteriorly. Short, unpigmented hairs sparsely cover body; longer hairs laterally and posteriorly, in longitudinal bands laterally.

Antenno-maxillary sense organ (AM) and mouth circled by brown spinules (Fig. 3); inflatable, pilose lobes lateral to mouth; verricule between antenno-maxillary sense organ and mouth. Two anterior spiracles (AS), brown, with 17–18 elliptical to circular openings on anteroventrally directed face and its margins (Figs. 2, 4). Ventral prolegs well developed (Figs. 2, 3, 5), 1 thoracic, 6 abdominal pairs. Crochets brown apically,

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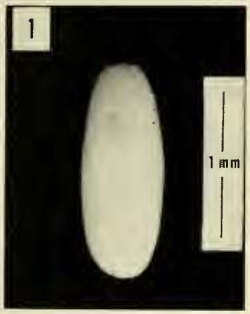
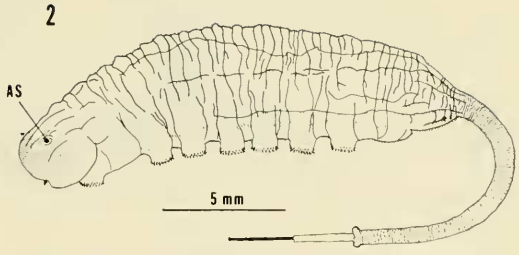
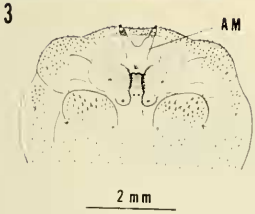
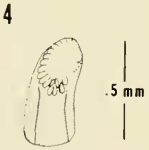
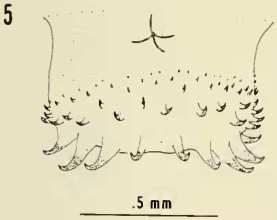
Fig. 1. *Mallota posticata*, egg. Figs. 2–8. *Mallota posticata*, mature third-instar larva. 2, lateral view. 3, ventral view, anterior end. 4, anteroventral view, left anterior spiracle. 5, lateral view, left fourth abdominal proleg. 6, cross section, arrangement of sensilla on abdominal segments 1–7. 7, ventral view, outline of protrusible

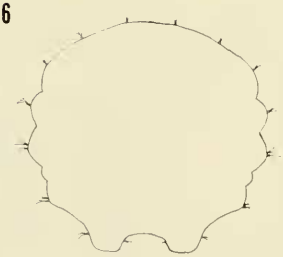


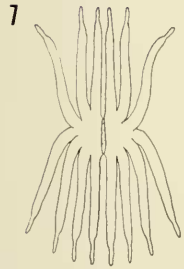


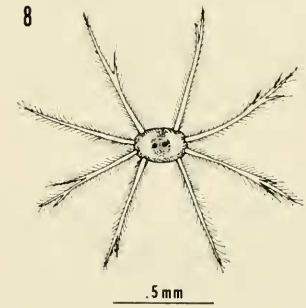












anal papillae. 8, spiracular plate of caudal respiratory tube. Abbreviations: AS, anterior spiracle; AM, antenno-maxillary sense organ.

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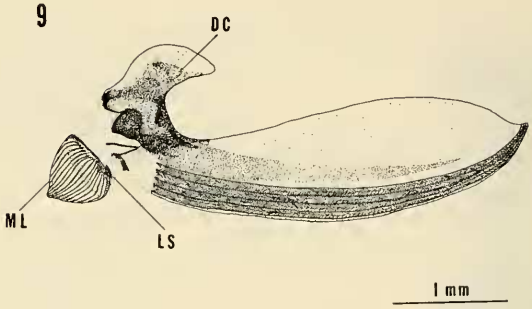

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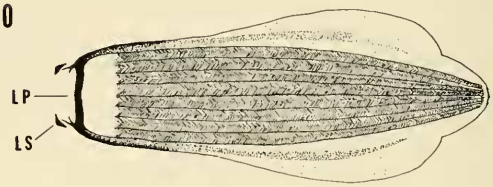

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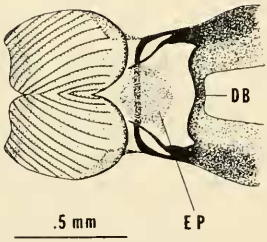

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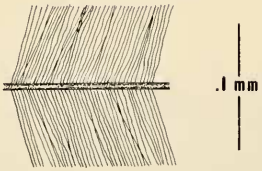

multiserial, in 4–5 rows becoming indistinct dorsally (Fig. 5); crochet arrangement posterolateral at anterior end of body, nearly lateral at posterior end. Abdominal segments 1–7 with 20 sensilla each (Fig. 6); arrangement of sensilla on other segments similar to that described by Hartley (1961) for *Mallota cimbiciformis*. Anal papillae protrusible, 6 anterior ones, 8 posterior ones (Fig. 7). Caudal respiratory tube immediately anterior to brown, sclerotized distal portion, bearing anteriorly directed, unpigmented spines on longitudinal cuticular ridges. Spiracular plate of caudal respiratory tube convex, with 2 prominent spiracular scars centrally, encircled by 8 laterally fringed setae (Fig. 8).

Cephalopharyngeal skeleton as in Figs. 9–13; length 4.1 ± 0.14 mm (N = 7). Mandibular lobes (ML) well developed, ribbed (Figs. 9, 11), with comb of filaments on inner ridges (Fig. 12). Pharyngeal sclerite with posteriorly projecting dorsal cornuae (DC) connected by dorsal bridge (DB) (Fig. 11), ribbed cibarial filter ventrally (Figs. 9–10). Pharyngeal sclerite black to amber anteriorly, translucent posteriorly except for light brown, posteriorly tapering strip at each margin of cibarial filter (Figs. 9–10). Two pairs of bars projecting anteriorly from pharyngeal sclerite (Fig. 9), black to amber; dorsal pair unconnected, at lateral margins of brownish epipharyngeal plate (EP) (Fig. 11); ventral pair joined by concave, black to brown, sclerotized bridge (Figs. 10–11); labial sclerite (LS) supported posteriorly by bridge. Floor of pharyngeal sclerite with cibarial filter of 9 filament-lined ridges, converging posteriorly (Fig. 10); inner 7 ridges with single row of filaments on each side (Fig. 13), outer 2 ridges with 1 row of filaments.

Puparium.—Length excluding caudal respiratory tube 14.9 ± 0.25 mm, maximum width 8.1 ± 0.14 mm (N = 15).

Inflated, tear-shaped in dorsal view (Fig. 14), fusiform in lateral view (Fig. 15), strongly convex dorsally, nearly flat ventrally. Light brown, entirely rigid. Longitudinal swelling at each dorsolateral margin; indistinct transverse plicae, increasing posteriorly. Sparsely pubescent, larval cuticular ornamentation present but indistinct. Two dehiscent plates at anterior end (Fig. 16); anterior plate trapezoidal, evenly convex, with diverging spiracles at anterior margin. Posterior plate abruptly turned anteroventrally

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Figs. 9–13. *Mallota posticata*, cephalopharyngeal skeleton. 9, lateral view. 10, ventral view, excluding mandibular lobes. 11, anteroventral view, junction between mandibular lobes and pharyngeal sclerite. 12, lateral projections on cuticular ridges of mandibular lobes. 13, filament-lined cuticular ridge of cibarial filter. Abbreviations: DB, dorsal bridge of pharyngeal sclerite; DC, dorsal cornua of same; EP, epipharyngeal plate; LP, labial plate; LS, labial sclerite; ML, mandibular lobe.

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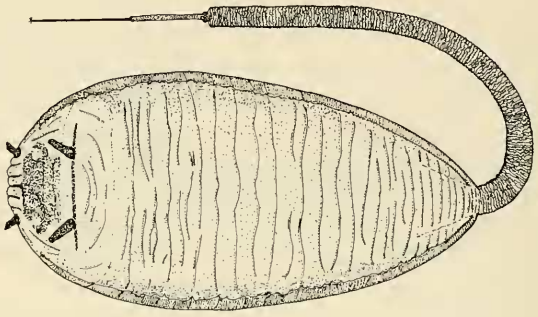
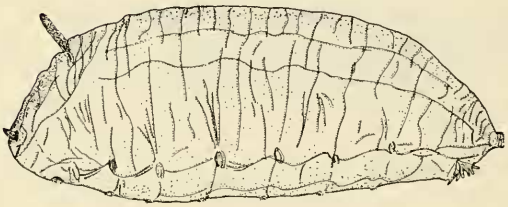


5 mm

15



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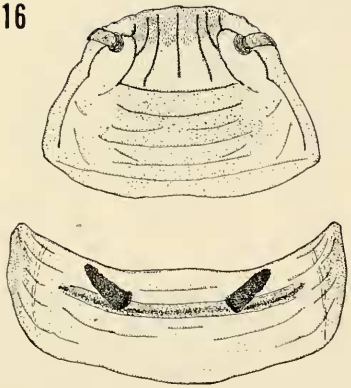

2 mm

17

.5mm

at lateral margins; dorsum nearly rectangular, slightly convex, with nearly straight, diverging, anterodorsally directed pupal respiratory horns. Horns with numerous tubercles except at base and on lower surface (Fig. 17); each tubercle with spiracular opening at apex.

Material studied.—Descriptions based on material from Sand Ridge State Forest, Mason County, Illinois; voucher specimens deposited in the Illinois Natural History Survey.

Johannsen's (1935) brief description of *M. posticata* immatures (preceded by a question mark) agrees with mine except for the number and the arrangement of anal papillae in the larva. He found 13 anal papillae, 6 anterior and 7 posterior, rather than the 14 anal papillae, 6 anterior and 8 posterior, reported here. He did not associate the larva with an adult and, thus, apparently described either another eristaline species, probably a *Mallota*, or a damaged specimen of *M. posticata*. Unfortunately, Lintner's (1882) description is too fragmentary to permit comparison.

The immature stages of the North American *M. posticata* differ from those of the sympatric *M. bautias* (Snow, 1949) and the european *M. cimbiciformis* (Coe, 1953; Hartley, 1961). Although Snow (1949) described only the puparium of *M. bautias*, he noted in a key that the larva has 7 anterior and 7 posterior anal papillae. Furthermore, in contrast to the *M. posticata* puparium, the *M. bautias* puparium described by Snow (1949), and others examined by me, have a nearly flat anterior dehiscent plate, the distal portion of the pupal respiratory horns bent dorsally, and distinct transverse plicae on the abdominal dorsum.

The *M. cimbiciformis* larva has no pubescence on the posterior abdominal dorsum, 25 openings on each anterior spiracle, and 12 anal papillae (Hartley, 1961). Any one of these characteristics separates *M. cimbiciformis* from *M. posticata*. In addition, the absence of dorsal abdominal pubescence and the greater number of spiracular openings on the anterior spiracle of the *M. cimbiciformis* puparium distinguishes it from the *M. posticata* puparium.

The general morphology of the cephalopharyngeal skeleton of *M. posticata* resembles that of several *Eristalis* species (Hartley, 1963; Wahl, 1900) and *Myiatropa florea* (L.) (Roberts, 1970), taxonomically related species with similar feeding habits. Therefore, Roberts' (1970) account of the function of the feeding structures in *M. florea* probably applies well to *M. posticata* and most other eristaline larvae.

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Figs. 14–17. *Mallota posticata*, puparium. 14, dorsal view. 15, lateral view, excluding caudal respiratory tube. 16, dehiscent plates. 17, posterodorsal view, left pupal respiratory horn.

Biology

Larvae were collected from treeholes in upright, living *Carya* spp., *Liquidambar styraciflua* L., *Populus deltoides* Marsh, *Quercus alba* L., *Q. marilandica*, *Q. velutina* Lam., and *Ulmus* sp. in Illinois, Indiana or Michigan. The openings to these treeholes occurred at various heights but were mostly near ground level. The cavities usually contained more than 3 liters of detritus and held standing water for more than 2 months out of the year. There were 1–51 larvae per treehole; the number generally increased with the quantity of detritus. The 51 larvae were in a treehole in *Populus deltoides* that contained approximately 60 liters of detritus. In the summer, larvae were usually near the bottom of treeholes where the particles of detritus were the smallest and the moisture was the greatest. Other organisms commonly found in the same treeholes included Acarina (Fashing, 1973, 1974, 1975 and 1976), helodids (*Elodes*, *Prionocyphon*), ceratopogonids, psychodids (*Telmatoscopus*) and rarely other syrphids (e.g., *Somula decora* Macquart and *Spilomyia longicornis* Loew). *Mallota bautias* larvae never occurred in treeholes containing *M. posticata* larvae.

The filter-feeding larvae of *M. posticata* consumed fine-grained detritus and other material trapped in treeholes. Most treehole detritus originates from trees, for example, from leaves, wood and acorns. Wind and the activities of ants facilitate the deposition of detritus in treeholes. In the laboratory, larvae often protruded and then pulsated their anal papillae while feeding. Thus, in addition to an osmoregulatory function (Krogh, 1943; Wichard and Komnick, 1974), the anal papillae may also be used to put food particles into suspension and to circulate them.

In nature, larvae attained full size and weight (0.35–0.55 grams) and entered diapause by late summer, approximately 2½–3½ months after hatching. Diapausing larvae were inactive, relatively inflexible and pink (due to particles of unknown origin suspended in the hemolymph). These larvae also had an empty gut and contracted cephalothoracic region.

Larvae overwintered in diapause in treeholes. In early spring, they commonly congregated against the inner treehole wall in moist but not water-soaked detritus. Exposure to cold was necessary for the termination of diapause and for the synchronous emergence of adults, an important consideration in any univoltine species. In the laboratory, full grown larvae that were subjected to 2°C and a 10 hour photophase and 14 hour scotophase for 4–5 months and then to 22°C and a 17 hour photophase and 7 hour scotophase pupariated over a 1–3 week period. By contrast, larvae that were continuously maintained at 22°C and on a 17 hour photophase and a 7 hour scotophase failed to pupariate within 14 months after hatching.

At Sand Ridge State Forest, larvae usually left treeholes from April to June and pupariated in the surface of the sandy soil within 1–2 m of

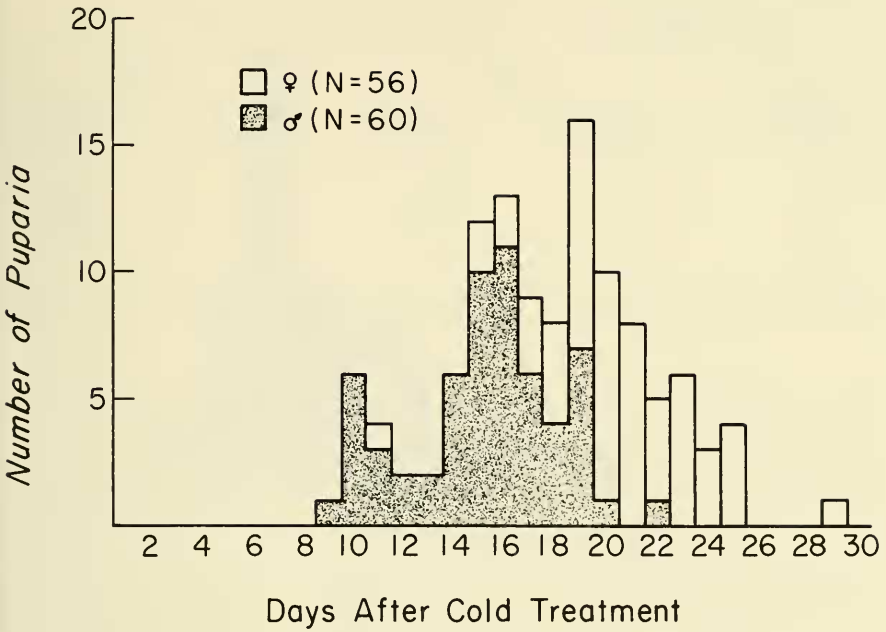

Fig. 18. Pattern of *Mallota posticata* pupariation after exposure to 2°C and a 10 hour photophase and a 14 hour scotophase.

the tree trunk. They occasionally remained in the treeholes and pupariated near the surface of the detritus in the cavity. Pupariation usually occurred over a 2 week period at any one treehole. Although puparia were frequently discovered, the actual departure of larvae from treeholes was witnessed only twice, at 1400 and 1515 CDT on 19 May 1975. Ants foraging in the vicinity attacked both larvae. One escaped and pupariated in the soil, and the other climbed the tree until out of sight. At 1100 on the following day, ants successfully captured and killed a larva at the same treehole.

In the laboratory, most larvae crawled out of rearing dishes between 1100 and 1900 of a 0400–2100 photophase, wandered on the sand up to several hours and finally pupariated in the sand, often under the dishes. The pupal respiratory horns protruded through the puparium 54–72 hours later. Larvae that were exposed to 2°C and a 10 hour photophase for 140 days began to pupariate only 9 days after they were switched to 22°C and a 17 hour photophase (Fig. 18). The main time from the termination of the cold treatment to pupariation was 15.2 ± 0.38 days for males and 20.4 ± 0.41 days for females. Males and females remained in the puparium 12–15 days and 13–15 days, respectively (Table 1). Most males (48.72%) eclosed on day 13, and most females (60.00%) eclosed on day 14. Similarly,

Table 1. Time spent in the puparium by both sexes of *Mallota posticata* at 22°C and on a 17 hour photophase and a 7 hour scotophase.

Days in puparium[1]	Males		Females	
	Number	% of total	Number	% of total
12	2	5.13	0	0.00
13	19	48.72	8	22.86
14	16	41.02	21	60.00
15	2	5.13	6	17.14
Total	39		35	

[1] Puparia were collected and observed at 1500 each day.

Lintner (1882) reported that a male and a female, respectively, spent 12 and 14 days in the puparium.

Eclosion was concentrated between 0600 and 1000, with a distinct peak at 0700, when the photophase extended from 0400–2100 (Fig. 19). In nature, individual adults were seen to eclose at approximately 0800, 1000, and 1100 CDT. Akre et al. (1973) also noted a morning peak in eclosion for the syrphid *Microdon cothurnatus* Bigot.

Adults frequented open, actinomorphic blossoms of species which produce substantial quantities of pollen per flower or inflorescence. In central Illinois, they fed on the pollen, nectar, or both of *Ceanothus americanus* L., *Celastrus scandens* L., *Cornus drummondi* Meyer, *C. racemosa* Lam., *Heracleum lanatum* Michx., *Osmorhiza* sp., *Pastinaca sativa* L., *Prunus serotina* Ehrh., *Ptelea trifoliata* L., *Rhus glabra* L., *Rosa carolina* L., *Rubus allegheniensis* Porter, *R. occidentalis* L., *Sambucus canadensis* L., and *Viburnum* sp. In other parts of their range, they visited *Maianthemum canadense* Desf. (Graenicher, 1910) and *Rosa setigera* Michx. (Robertson, 1928). At Sand Ridge State Forest, adults foraged primarily on *Cornus drummondi*, *C. racemosa*, *Rosa carolina* and *Sambucus canadensis* and demonstrated considerable flower constancy (Maier, 1977b).

Table 2 shows that virgin females required pollen, a protein source, for normal ovarian development. In the absence of pollen, little growth was evident after 8 days; but with pollen some eggs were fully formed after 2–4 days. Schneider (1948) also found that pollen consumption was a prerequisite for rapid ovarian development in the syrphid *Episyrphus balteatus* (De Geer).

Maier (1977b) noted that the mate-seeking activities of *Mallota posticata* males were coordinated temporally and spatially with female activity. In the morning, males searched blossoms to find feeding females. In the afternoon, most males defended territories around wet treeholes and attempted to mate females arriving to oviposit. Matings occurred at both sites.

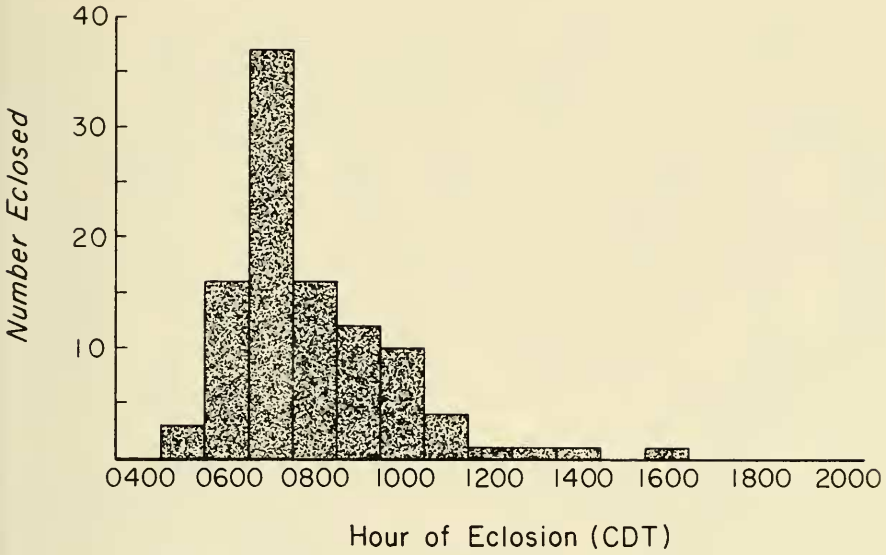

Fig. 19. Periodicity in the eclosion of *Mallota posticata* adults at 22°C and on a 17 hour photophase (0400–2100 CDT).

No overt courtship was evident prior to copulation in *M. posticata*. Males responded almost instantaneously to flying or stationary females. In less than 2 seconds, a male grasped a female and achieved genital contact. Often a brief flight followed with the male carrying the female. Pairs alighted within 1–10 m of the site of encounter, generally on foliage, the trunk of a tree or occasionally on the forest floor. The male usually hooked his prothoracic and mesothoracic tarsal claws onto the costal wing margins of the female. He clasped the abdomen of the female with his metathoracic tibiae and enlarged femora. A shrill sound, apparently created by the vibrating thoracic sclerites of one or both flies (Aubin, 1914), fre-

Table 2. The average weights (mg) of the ovaries of unmated *Mallota posticata* females that were fed pollen or pollen-free diets for 2, 4, 6 or 8 days after eclosion.

Days after eclosion	Number	Without pollen	Number	With pollen
2	4	3.5 ± 0.28	5	21.0 ± 3.28
4	3	3.5 ± 0.19	4	26.5 ± 4.38
6	3	3.7 ± 0.26	4	32.6 ± 1.47
8	3	3.8 ± 0.06	5	46.7 ± 5.66

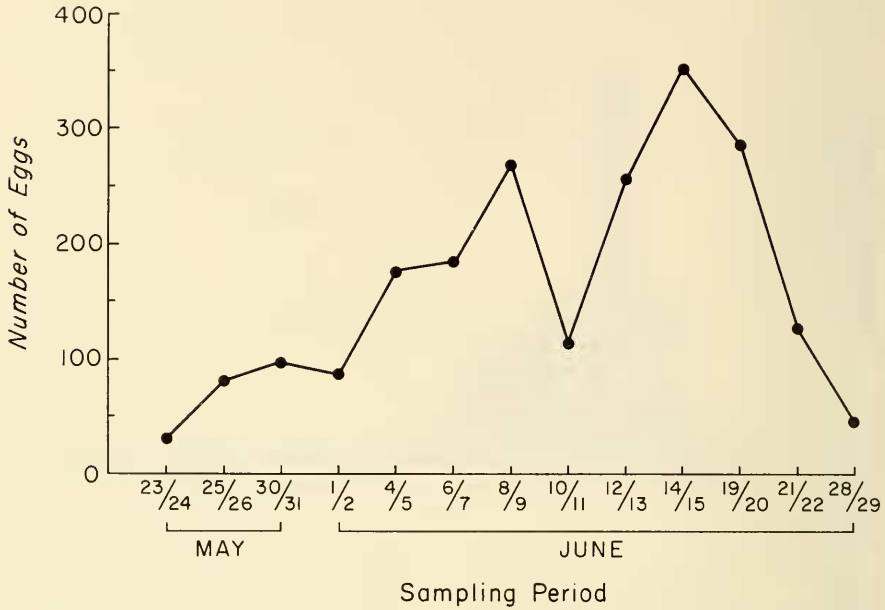

Fig. 20. Number of *Mallota posticata* eggs laid in 20 artificial oviposition sites during 2-day periods between 23 May and 29 June 1976.

quently accompanied the initiation of mating. If a female was not initially receptive, the male moved anteriorly, maintained a firm grip on the female and vigorously stroked the eyes of the female with his prothoracic legs. A male repeatedly stroked an unreceptive female at brief intervals until one or both departed.

In the laboratory, both sexes mated frequently during the first 20 days of their life. One male captured at a flower, marked and released was resighted 11 days later while mating near a treehole. Most pairs copulated for 1–3 hours in cages, but the duration of actual sperm transfer is unknown.

Gravid females flew upwind to treeholes. They circled all trees within 10 m of a tree containing a treehole and, after locating the treehole, usually hovered at the entrance for 0.5–1.0 minute before landing. Hovering often included intermittent 0.5–1.0 second bobbing or down-and-up flights before the opening of a treehole. After landing, females meticulously probed crevices in the bark near the opening or in the wood of the inner wall of the treehole with their ovipositor. Once they selected an oviposition site, they rapidly laid a group of eggs. Eggs were deposited in one or rarely two areas of a treehole, typically under bark at the entrance, above the water line on the inner treehole wall or on the water surface. The mean egg clutch, which was laid in detritus-containing artificial oviposition sites

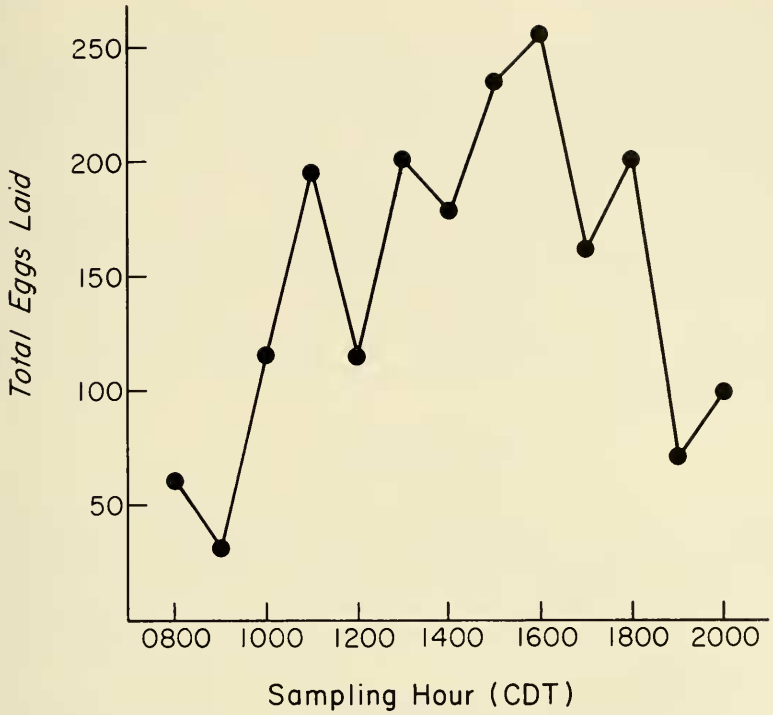

Fig. 21. Total number of *Mallota posticata* eggs laid per hour in 30 artificial oviposition sites uniformly distributed over 0.5 hectare of forest floor and monitored for 10 days in June 1976.

placed in the forest understory, was 17.7 ± 1.30 eggs (N = 103). The mean time from hovering to departure at a natural treehole was 20.3 ± 3.63 minutes (N = 6). Thirty females placed in the same laboratory cage laid 11,474 eggs over 30 days, an average of 382.4 eggs each.

In 1976 at Sand Ridge State Forest, egg-laying in artificial oviposition sites was concentrated in June, with a peak on 14–15 June (Fig. 20). Little oviposition occurred prior to mid-May or after early July. The oviposition peak on 14–15 June probably reflects a peak in female emergence in early June. In the laboratory, females commenced ovipositing 3–6 days after eclosion and deposited most of their eggs in the first 15–20 days of their life. In nature, females oviposited primarily between 1100 and 1800 CDT in artificial oviposition sites (Fig. 21). The relatively low egg-laying activity between 0800 and 1000 corresponds to the period when females are feeding at flowers growing in fields adjacent to forests (Maier, 1977b).

In laboratory cages, the mean longevity of adults was 19.2 ± 2.23 days (N = 23) for males and 21.4 ± 2.33 days (N = 25) for females. Two males

of unknown age, which were captured at flowers and marked, were resighted 11 and 15 days later.

In conclusion, several of the significant developmental events in the life of *M. posticata* have apparently been selected to occur in the spring when environmental conditions are most favorable. After the termination of diapause, larvae pupariate and adults subsequently eclose as numerous species of flowers began to blossom near suitable larval habitats in deciduous forests. Most spring flowers have an unspecialized floral morphology which permits the adult syrphids to feed easily on the pollen, a requisite for rapid ovarian development, and on the nectar, an energy source. Furthermore, fragile, young larvae probably have a better opportunity for survival in the spring than they do later because the water level in treeholes is highest and the quantity of detritus is greatest due to the accumulation during the previous two seasons.

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Department of Entomology, University of Illinois, Urbana, Illinois 61801.

Present address.—Department of Entomology, Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, Connecticut 06504.